TIN MINERALIZATION AT THE WON PROSPECT, WEST-CENTRAL ALASKA

By Roger E. Burleigh

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UNITED STATES DEPARTMENT OF THE INTERIOR

Manuel J. Lujan Jr., Secretary

BUREAU OF MINES

T S Ary, Director

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ABBREVIATIONS USED IN THIS REPORT

°	degree
ft	foot
>	greater than
in	inch
<	less than
mi	mile
µm	micrometer
M	million
Ma	million years before present
oz/st	troy ounces per short ton
ppm	parts per million
%	percent
lb	pound
st	short ton

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ABSTRACT

Tin mineralization at the Won prospect was investigated by the Bureau of Mines in July 1989 and June 1990 as part of an ongoing investigation of the tin resource potential in Alaska. The Won prospect is located 40 miles north of McGrath, Alaska. The tin deposits at the Won prospect are associated with several northwest trending, moderately dipping breccia-vein structures developed in tourmaline- and quartz-altered hornfels. Tin occurs in brecciated hornfels with cassiterite matrix, cassiterite druse on fracture surfaces of open spaced, crackle breccia, and as disseminated grains in quartz veins containing minor silver, arsenic, copper, antimony, and zinc mineralization.

Based upon limited sampling, and estimated combined tin resource of approximately 25.3 M lb tin is indicated for two of the principal breccia structures at the Won prospect, the Dog Day and the South veins. Additionally, 7,700 linear feet of tin-mineralized breccia vein structure can be estimated from projections of other individual breccia vein occurrences.

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INTRODUCTION

The U. S. Bureau of Mines has investigated the tin resource potential of Alaska for several decades. This work has been done because tin is vital to industries in the United States, that the United States relies on foreign countries to supply over 70% of its annual consumption (1)[2], and that Alaska is the only portion of the United States that contains world-class tin deposits.

In 1989 and 1990, the Bureau investigated the Won tin prospect in west-central Alaska (fig. 1). The Won prospect is one of several recently discovered tin deposits that are distributed within the upper Kuskokwim River drainage. Another notable tin occurrence is the Win deposit (2). The Cloud prospect, and the Mystery and Telida Mountains areas may also contain significant tin deposits (fig. 1).

This report describes the extent, mineralogy, morphology, distribution, and resource potential of the polymetallic tin-rich breccia veins that comprise the Won prospect.

LOCATION

The Won prospect is 40 air miles due north of the village of McGrath (fig. 1) and can be reached only by helicopter. A private landing strip is located at a placer mine on Colorado Creek 12 miles to the northwest. An excellent camp site is in the main north-south drainage which crosses the prospect (fig. 2). It consists of 10 ft by 10 ft plywood tent platforms, a helicopter landing pad, and a flowing creek nearby.

HISTORY

In 1980 the U.S. Geological Survey (3) identified anomalous levels of tin, tungsten, bismuth, lead, silver and arsenic in stream sediment samples from creeks draining a set of hills in central Alaska. In 1983 exploration for tin-silver mineralization resulted in the discovery of the Storm (Anaconda Minerals Co.) and the Won (Duval Corp.) prospects. The Storm prospect consisted of a group of claims that surrounded Duval's claims.

In 1984, Anaconda Minerals Co. drilled six shallow diamond drill holes on three mineralized structures discovered on their claim block. Anaconda Minerals Co. conveyed their claims to the Cook Inlet Region Inc. (CIRI) in 1985. No work has been done on the claims since 1987.

PHYSIOGRAPHY

The tin veins occur in a roundish set of hills, which rise up to 2,000 ft above the surrounding terrain. A prominent north-south trending, unnamed creek transects the hills and drains northward into the Susulatna River. Alder and spruce grow densely in the creek bottoms at 1,400-1,700 ft elevation. A thin veneer of tundra intermittently covers talus strewn slopes at higher elevations. The country is open and easy to traverse on foot.

GEOLOGY

Bedrock geology of the prospect consists of a sequence of clastic marine sedimentary rocks that have been widely metamorphosed to hornfels and tourmalinized and silicified to varying degrees. A few andesitic and rhyolitic dikes cut these units and are also locally altered. Several northeast-trending, tin mineralized, breccia vein structures crosscut the hornfels.

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[2]Underlined numbers in parentheses refer to references found in the reference section preceding the appendix.

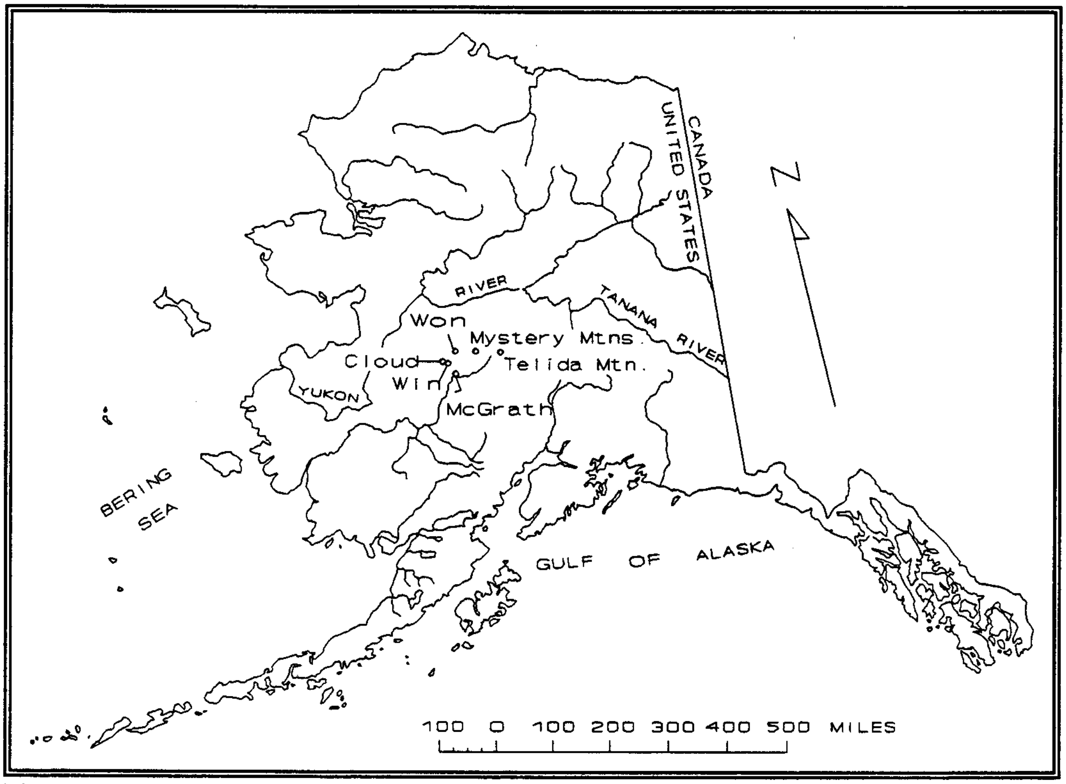

Figure 1. Location map of the Won, Win, and Cloud prospects and the Mystery and Telida Mountains.

Sedimentary Rocks and Hornfels

Sedimentary rocks at the prospect are part of the Kuskokwim Group of late-Early Cretaceous to Late Cretaceous age (4). They comprise a sequence of mudstone and siltstone, which grade upwards into locally fossiliferous lithic sandstone, siltstone, and fine pebble conglomerate.

The sedimentary rocks strike parallel to the regional northeast trend and dip gently to moderately south (fig. 2). Local deviations from the regional trend occur in the vicinity of vein and breccia structures.

Sedimentary rocks are variably metamorphosed to hornfels and specific metamorphic facies in the hornfels are not defined. The hornfels developed in the lithic sandstones is hard and compact, but grades to less competent sandstone away from the central mass of the hills where the breccia veins are found. Hornfels is widely altered disseminated and veined tourmaline is abundant. Tourmaline lends a purplish brown hue to the siltstone and is generally very fine-grained. Tourmaline alteration occurs as finely dispersed grains and as compact masses giving a variegated appearence to the brecciated hornfels. Near breccia vein structures the hornfels is distinctly gray in color and silicified.

Igneous Rocks

Igneous rocks include leucocratic rhyolite dikes, transecting the southwest side of the hornfels, and fine-grained andesite dikes, that transect the north and northeast side (fig. 2). Dikes trend approximately 140-150° and are steeply dipping. The dikes are up to 50 ft wide.

Patton (5) states that the andesite dikes are related to widespread, high-potassium, calc-alkaline, volcanic-plutonic activity that occurred throughout the Medfra Quadrangle and elsewhere in central Alaska between 59 and 71 Ma (6). Similar volcanic-plutonic complexes are found to the southwest of the Medfra Quadrangle into the Sleetmute Quadrangle (4). At other volcanic-plutonic complexes in the region, where dacitic to andesitic dikes are related to stocks, the stocks have whole rock compositions that include monzonite, quartz monzonite, and granodiorite (6).

Although there are no large exposures of plutonic or volcanic rocks near the prospect, the dikes at the Won prospect are chemically similar to dikes which are related to volcanic-plutonic complexes in the region (6). The more mafic dikes range from andesite to rhyodacite in composition and are fine-grained, equigranular, and hypidiomorphic in texture. Potassium feldspar, biotite, hornblende, and plagioclase constitute the major rock-forming minerals. Secondary minerals include quartz, ilmenite, tourmaline, chlorite, and a carbonate of unknown composition. Phenocrysts of zoned plagioclase are sparse. Major oxide and select trace element data for the andesite and rhyolite dikes are presented in table 1.

Rhyolite dikes are less common than andesite dikes. These dikes contain no mafic minerals and are aphanitic in texture. A 10-ft wide outcrop of rhyolite is located at map location 26, figure 2.

Table 1. --Major oxide and trace element analyses of rhyolite and andesite dikes

Map Number	Sample Number	Al_2O_3 %	CaO %	Fe_2O_3 %	FeO %	K_2O %	LOI %	MgO %	MnO %	Na_2O %	P_2O_5 %	SiO_2 %	TiO_2 %	Totals %
3	KS27656	18.0	1.77	3.0	9.9	1.27	5.98	6.67	0.51	0.84	0.29	49.1	1.6	98.93
4	KS27657	17.7	3.94	2.5	8.82	0.32	4.88	6.64	0.22	1.27	0.25	49.9	1.65	98.09
11	KS23188	16.1	6.0	1.1	4.47	1.94	4.52	2.96	0.16	3.40	0.28	56.5	0.98	98.41
15	KS27506	15.1	2.36	4.14	5.9	2.25	4.85	5.95	0.14	3.16	0.22	51.7	1.64	97.83
21	KS27503	15.0	3.28	4.32	5.56	1.97	3.49	5.47	0.18	3.66	0.12	52.5	1.77	97.32
26	KS27521	13.1	4.72	2.62	5.87	1.83	3.34	6.11	0.15	1.98	0.13	55.1	1.18	97.83
48	KS27510	14.8	0.04	0.53	0.06	4.27	1.82	0.05	0.02	2.29	<0.01	75.5	0.02	97.70
56	KS27667	16.4	0.48	1.32	2.05	3.15	3.19	1.95	0.08	3.34	0.32	65.2	1.08	96.24

Map Number	Sample Number	Ba ppm	Nb ppm	Rb ppm	Sr ppm	Zr ppm	Y ppm	Sn ppm	Ce ppm	Ta ppm	Rock Type
3	KS27656	510	24	52	176	122	29	370	-	-	Andesite
4	KS27657	140	34	14	214	137	35	700	-	-	Andesite
11	KS23188	1200	14	49	420	145	16	<5	<29	1	Andesite
15	KS27506	1300	13	140	240	145	19	140	51	<1	Andesite
21	KS27503	580	17	68	295	160	18	435	50	<1	Andesite
26	KS27521	520	13	95	340	135	11	83	56	<1	Andesite
48	KS27510	100	24	240	28	29	32	39	10	5	Rhyolite
56	KS27667	1500	32	126	489	303	31	340	-	-	Rhyolite

Note: Ba, Nb, Rb, Sr, Zr, Y, Sn, Ce, and Ta analyzed by X-ray fluorescence except where noted. Whole-rock oxides analyzed by direct coupled plasma emission after HF-HNO_3-$HClO_4$-HCl extraction except for FeO. FeO analyzed by titrametric methods. LOI (loss on ignition) determined by gravimetric methods

Note: Map number refers to map locations on figure 2.

Dikes at the Won prospect all exhibit some degree of alteration. Away from the area of hornfels the andesite dikes exhibit a greater degree of carbonate alteration and contain minor amounts of chalcopyrite and sphalerite (map location 11, fig. 2). A pyrrhotite-chalcopyrite-sphalerite-bearing andesite dike cropping out at map locations 3 and 4 (fig. 2), is enriched in tin, with concentrations of 370 and 700 ppm, respectively.

An andesite dike sampled at map locations 21 and 15 (fig. 2), is substantially altered and highly enriched in copper and tin. These samples respectively contain 1.24 and 2.3% Cu and 140 and 435 ppm Sn. A stockwork quartz-sulfide-cassiterite system parallels and overlaps this dike. The elevated tin and copper content of dikes cutting hornfels is probably related to the tin-mineralizing hydrothermal system that mineralized the breccia vein structures.

Only two rhyolite dikes were sampled (map numbers 48 and 56, table 1). These dikes contain tin concentrations of 39 to 340 ppm Sn respectively.

Aeromagnetic Survey Interpretation

An aeromagnetic survey by the USGS, flown in 1978 (6) and interpreted by Patton and others in 1980 (5), identified a "cup-shaped negative anomaly" approximately 3.1 mi (5 kilometers) in diameter" centered on the Won prospect. The survey was flown at 984 ft (300 meters) above the ground at a line spacing of 1 mi (1.6 kilometers). Patton and others (5) interpret the anomaly as reflecting a "single large reversely magnetized body at shallow depth". The reverse magnetic signature is interpreted to reflect remanent magnetism induced in the rocks as they cooled during a period when the earth's magnetic field was reversed (5).

As figure 2 shows, dikes cover a very small surface area at the prospect and could hardly account for a large aeromagnetic anomaly. Therefore, Patton and others suggest that these dikes coalesce at depth to form a single igneous body.

Vein Deposits

Vein deposits at the Won prospect largely consist of breccia veins that are cemented by minor amounts of quartz, tourmaline, or metal-oxides. Mapping has shown that the breccia veins trend 115-125° or 150-160° and generally dip moderately to steeply south with minor sympathetic structures dipping steeply north.

The following list generalizes the textural and mineralogic characteristics observed in the collective vein population and the subsequent text describes observations of individual vein systems.

1. Gossany, silicified, brecciated hornfels contain abundant goethite, limonite, psilomelane, and unidentified metal-oxide cements. Locally, abundant cassiterite lines abundant open spaces. Individual breccia veins vary from inches to 6-7 ft in width.

2. Buff-colored, silicified, brecciated, and crackle brecciated hornfels are cemented with thin films of quartz plus or minus tourmaline. Breccia contains abundant open space and not matrix supported. Locally, cassiterite lines voids and joint planes. Narrow cassiterite-rich portions up to 8 in thick are present within zones of crackle breccia.

3. Massive milky quartz veins, generally less than 1 ft wide taht are green scorodite stained, and contain minor arsenopyrite, tetrahedrite, and rare cassiterite. Strike lengths are short. They are isolated within breccia vein systems.

4. A zone containing a stockwork of narrow anastomosing quartz veinlets with minor amounts of arsenopyrite, chalcopyrite, tetrahedrite, and cassiterite occurs at the prospect.

5. Tourmaline (black, fine-grained) is present along quartz vein margins, in vugs, and as thin black massive veinlets.

All or only some of the above characteristics may be found in any one breccia vein. Stockwork veining was found in only one area (Stockwork Zone, fig. 2). Breccia veins change considerably over short distances from micro- to coarse angular fragmental or crackle breccias and vary in width from a few inches up to 20 ft. The larger veins usually incorporate intensely fractured and often mineralized wall rock as part of their estimated width. Abundant angular voids and joints are often lined with druse of fine-grained cassiterite when near tin-mineralized breccias. The gossany breccia veins generally lack primary sulfide minerals.

Cassiterite appears to represent the latest stage of hydrothermal activity and to have precipitated in open spaces. This characterisitic persists in breccia veins throughout the prospect.

Names of the veins described in this report are those used by Anaconda Minerals (8) and applied by the Bureau for report purposes only. Tables 2 through 10 list the analyses for gold, silver, arsenic, copper, iron, lead, antimony, tin, tungsten, and zinc for all of the samples pertaining to these veins. The appendix lists analyses of additional elements.

Analytical Methods

In tables 2 through 10, gold, silver, arsenic, iron, antimony, tungsten and zinc analyses are by instrumental neutron activation analysis. Tin analysis is by X-ray fluorescence except where * denotes tin-assay, and copper and lead are analyzed by atomic absorption spectrometry. All analyses were conducted by Bondar-Clegg & Co. Ltd., 12980 West Cedar Dr., Lakewood, Co. 80228.[3]

Stockwork Zone

The Stockwork zone is comprised of hornfels that contains minor amounts of arsenopyrite, chalcopyrite, sphalerite, tetrahedrite and cassiterite in a stockwork of narrow anastomosing quartz plus or minus tourmaline veinlets (fig. 3). Select samples contain elevated gold values; map numbers 19 and 22, table 2, contained 1.55 and 0.58 ppm Au respectively. Gold occurs as 9 to 18 μm size grains within healed crushed zones in quartz veins that are marked by streams of secondary fluid inclusions. Both cassiterite and arsenopyrite are found in quartz veins containing gold. A copper-rich, sheared and altered, andesite dike contains up to 2.64% Cu and 435 ppm Sn within the Stockwork Zone (map numbers 15 and 21, table 2).

Stockwork quartz veining and associated metallic mineralization cross-cut the tourmalinized and brecciated hornfels, often with a density of 20 to 30 veinlets per foot (fig. 3). Veinlets generally vary in width from ⅛- to ½-in; however, larger veins do occur with widths up to 1 ft.

Gemini Veins

Breccia veins in the Gemini vein area consist of two closely spaced, parallel veins (fig. 4). Tin values ranged from 220 to 5,700 ppm in chip samples that spanned 3.3 to 16.5 ft at the north vein (map locations 27-32, 37-38, fig. 4, table 3).

Gemini vein south is similar to the northern vein except a high-grade zone (3.51% Sn across 3.5 ft, map number 35, table 3) is localized in an 8-in-thick, moderately dipping, cassiterite-matrix supported breccia vein bounded by tourmaline and silica-cemented crackle breccia (fig. 5). Rocks with high concentrations of cassiterite crop out on the east side of the ridge and could not be traced along the breccia vein to the west side. Gemini vein north is oriented 124°/45°S and the south vein is oriented 123°/38°S. From outcrop exposures, the north vein has a minimum strike length of 600 ft and the south vein has a minimum strike length of 300 ft (fig. 2).

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[3]The use of Bondar-Clegg and Co. Ltd. laboratories does not imply endorsement by the U.S. Bureau of Mines.

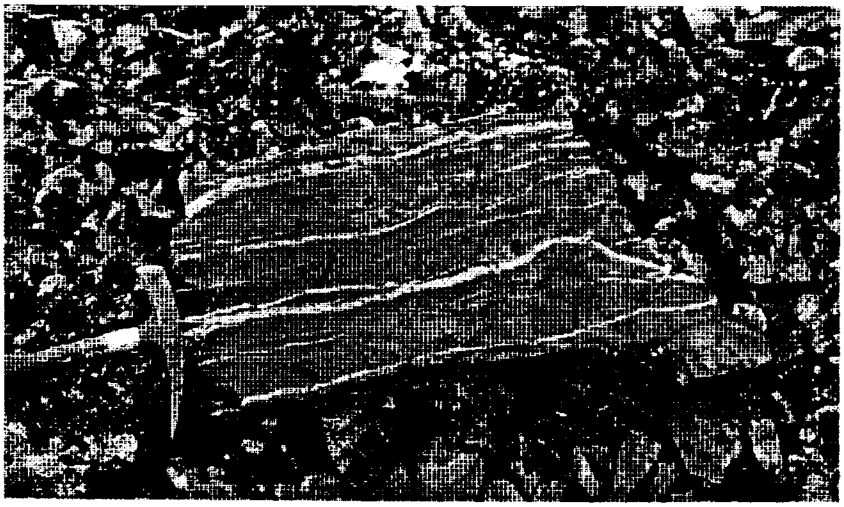

Figure 3. --Ribbon quartz stockwork veined hornfels rubble with arsenopyrite, tetrahedrite, chalcopyrite, sphalerite and cassiterite.

Table 2. --Analytical results for samples of the Stockwork zone

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe pct	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm
15	KS27506	<5	6	99	26400	7.3	<2	3.9	140	<2	1100
16	KS27507	18	10	1780	370	5.2	177	65.1	260	13	<200
19	KS27505	1550	86	19400	5615	4.0	1599	440.0	205	<15	<200
20	KS27504	100	<5	4580	560	6.3	198	57.8	230	11	330
21	KS27503	<5	<5	159	12392	6.7	<2	3.4	435	4	830
22	KS27502	558	15	>30000	6667	5.7	68	136.0	300	15	1700

Map Number	Sample Number	Sample Description
15	KS27506	Grab; malachite-azurite stained carbonate-tourmaline altered andesite dike
16	KS27507	Random chips; gossany breccia and fault gouge in hornfels
19	KS27505	Select grab; 2-in quartz vein: arsenopyrite, chalcopyrite, tetrahedrite, cassiterite
20	KS27504	Random chip of 15- to 20-ft-wide fault gouge and breccia zone
21	KS27503	Grab; malachite-azurite stained carbonate-tourmaline altered andesite dike
22	KS27502	Select grab; quartz-arsenopyrite-tourmaline veins from laminar stockwork in siltstone

Note: all map numbers reference locations on figure 2.

Table 3. --Analytical results for samples of the Gemini veins

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe %	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm
27	KS27527	<5	5	136	62	6.2	94	32.7	310	74	<200
28	KS27528	62	6	438	67	6.8	228	79.1	1100	31	<200
29	KS27524	120	5	146	76	4.3	338	68.8	5700	46	<200
30	KS27531	7	<5	138	178	9.0	74	69.2	1500	150	330
31	KS27525	33	<5	70	36	3.3	10	38.9	385	31	<200
32	KS27526	34	<5	58	51	4.0	113	43.1	625	35	<200
33	KS23429	32	20	636	322	23.0	344	150.0	*244000	150	1500
34	KS27501	13	13	582	26	3.5	305	52.5	*445000	1120	<200
35	KS27533	7	22	836	54	7.1	240	43.7	*35100	87	340
36	KS27532	<5	47	864	94	7.6	239	34.8	905	1730	390
37	KS27529	69	2	437	243	6.5	11	67.5	220	44	<200
38	KS27530	<5	19	1610	159	7.6	107	73.3	220	120	<200

Map Number	Sample Number	Sample Description
27	KS27527	44 in continuous chip of silcified fractured siltstone and 4 in Fe-oxide gossan
28	KS27528	16 ft semi-continuous chip of variably brecciated-fractured siltstone
29	KS27524	9 ft continuous chip of variably fractured and brecciated siltstone
30	KS27531	40 in continuous chip of fractured, gossany hornfels with 6 in gossany breccia zone
31	KS27525	3.5 ft continuous chip of buff-colored silcified brecciated siltstone
32	KS27526	12 ft continuous chip of variably brecciated to fractured, silicified siltstone
33	KS23429	Random chips of olive-colored, silicified siltstone breccia; abundant cassiterite
34	KS27501	High-graded cassiterite-matrix siltstone breccia; rubble boulder 3 by 2 by 1 ft
35	KS27533	44 in continuous chip; silicified, fractured siltstone; 8 in cassiterite-matrix breccia
36	KS27532	8.5 ft continuous chip of variably brecciated-fractured gossany siltstone
37	KS27529	10 ft continuous chip of variably brecciated-fractured, silicified siltstone
38	KS27530	16.5 ft continuous chip of variably brecciated-fractured, silicified siltstone

Note: all map numbers reference locations on figure 4

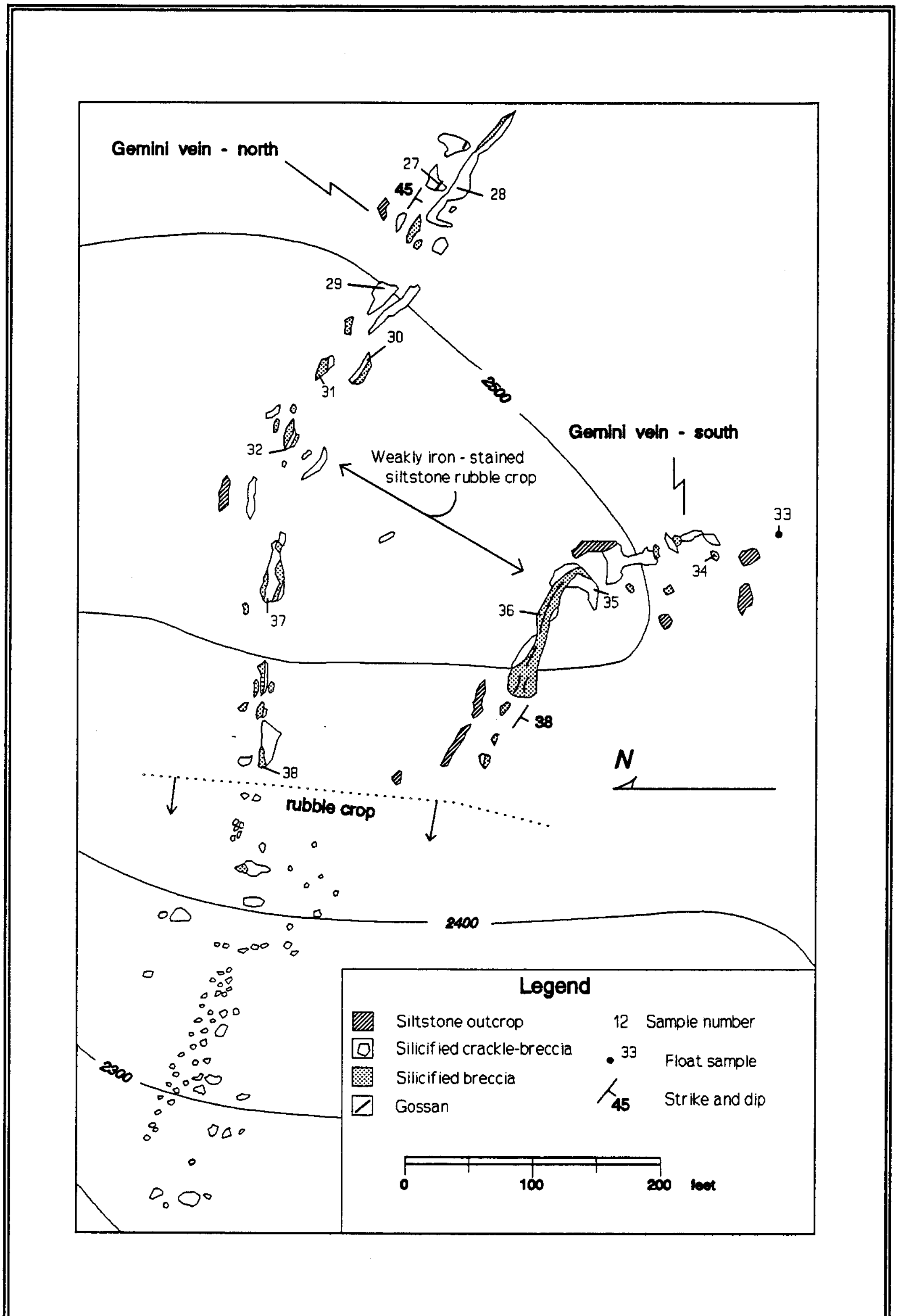

Figure 4. --Detail geologic and sample location map of the Gemini veins.

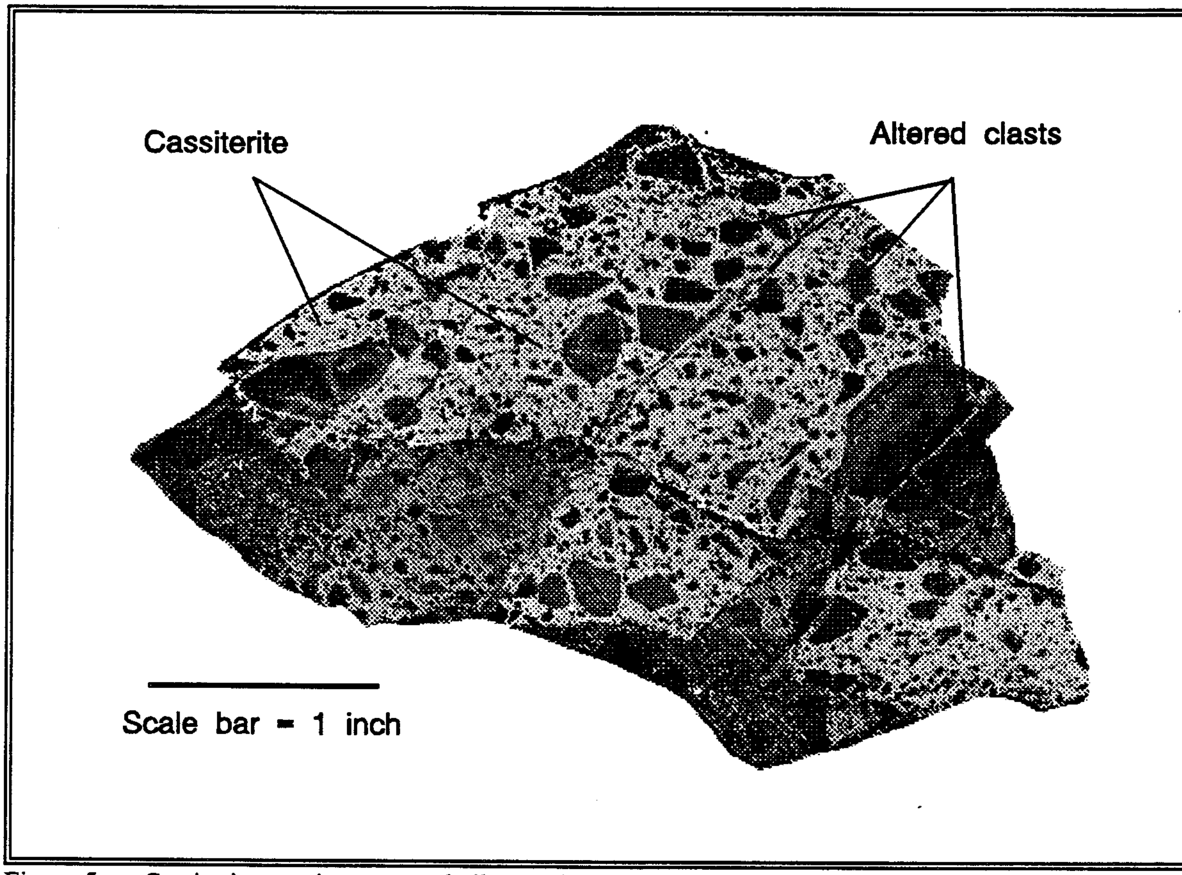

Figure 5. --Cassiterite-matrix-supported siltstone breccia; White matrix is cassiterite coated with elemental tin by chemical etching.

Tin Ridge Veins

Tin Ridge breccia veins are comparable to the Gemini breccia veins. Individual breccia veins are not easily defined as most mineralized material is rubble. In rubble samples cassiterite fills voids and lines fracture openings in the silicified crackle brecciated hornfels. It also occurs in high concentrations with quartz as a matrix to angular breccia clasts. Cassiterite-mineralized rubble is broadly distributed several tens of feet perpendicular to concentrations of cassiterite-rich breccia vein rubble. Samples contained from 0.08 to 9.3% Sn (49-53, table 4).

A possible extension of the Tin Ridge system may be projected on strike to the southeast to map location 53 (fig. 2, table 4), where a 1 ft by 3 ft by 2 ft rubble boulder of cassiterite-bearing, gossany, and silicified crackle breccia occurs in a linear trough which cuts across the nose of a ridge. The Tin Ridge system has a possible strike length of approximately 3,000 ft by projection to map location 53 (fig. 2, table 4). An estimate of the width cannot be established without drilling.

Prospect Pit Vein

The Prospect Pit vein is so named because a series of prospect pits are distributed across a rubble exposure of gossany, brecciated hornfels. The pits expose a mineralized zone estimated to be 10- to 15-ft-wide. A strike length of at least 1,300 ft is indicated by the distribution of vein rubble material, which strikes approximately 125°.

The breccia vein system consists of metal-oxide cemented breccias, anastomosing milky quartz-veined breccias (map number 65, table 5), and silicified crackle breccias (map number 64, table 5). Although high concentrations (10-30%) of cassiterite occur in breccias with abundant milky quartz, textural relations indicate that the cassiterite is not coincident to quartz deposition. Rare, fist-sized specimens of coarse-grained (one to several mm) massive cassiterite containing 10% breccia fragments were found in the rubble.

Cassiterite distribution is spotty and rocks with minor cassiterite were difficult to distinguish from barren rock because of the copious amount of metal-oxide cement that coats fracture surfaces. Sulfide minerals were not observed. Samples contained from 0.13 to 0.5% Sn (64-65, table 5).

Table 4. --Analytical results for samples of the Tin Ridge veins

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe %	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm
49	KS27511	18	-5	8500	90	3.1	24	35.1	*32500	35	-200
50	KS27513	12	60	1140	143	5.7	1314	237.0	7000	32	470
51	KS27535	19	-5	6440	655	13.0	186	210.0	855	18	870
52	KS27515	-5	-5	734	171	10.0	78	78.6	4700	27	1100
53	KS27539	21	280	5910	743	10.0	5615	265.0	*93000	89	2000

Map Number	Sample Number	Sample Descriptions
49	KS27511	Float: Cassiterite-rich silicified brecciated hornfels; moderately abundant Fe-stain
50	KS27513	Select chips of highly brecciated segments of 40-ft-wide fracture and shear zone
51	KS27535	Random chip off 4 by 4 by 2 ft boulders of gossany brecciated siltstone
52	KS27515	Random chip of Fe-oxide cemented brecciated sandstone; variably abundant cassiterite
53	KS27539	Grab of 3 by 2 by 1 ft boulder of gossany, brecciated-fractured siltstone; arsenopyrite and cassiterite in quartz veinlets

Note: all map numbers reference locations on figure 2

Table 5. --Analytical results for samples of the Prospect Pit vein

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe %	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm
64	KS27661	-	-	-	-	-	-	-	1300	-	-
65	KS27519	32	15	48	10	1.2	329	20.8	*5000	19	-200

Map Number	Sample Number	Sample Description
64	KS27661	Random chip of 10-ft-wide gossany, crackle brecciated hornfels
65	KS27519	Select chips of cassiterite-bearing, quartz veined, buff-colored fractured sandstone

Note: all map numbers reference locations on figure 2

South Vein

The South vein was originally located (1983) and drilled (1984) by Anaconda Minerals Co. (8). A strike length of approximately 4,300 ft is estimated by the trace of rubblecrop exposures of gossany breccia vein material. From three widely spaced points, the orientation of the South vein was computed to strike about 130° and dip 28° to the southwest. Diamond drill hole cross-sections (8) indicate that the South vein dips 45° to the southwest similar to the nearby Gemini veins. Table 6 lists analytical results of rubblecrop samples taken by the Bureau along the South vein. Samples contained from 0.14 to greater than 2% Sn (39-45, table 6).

Anaconda Minerals Co. drilling confirmed a moderately dipping tin-bearing structure with values up to 8.15% Sn and 3.91 oz/st Ag over 1.5 ft within zones of lower grade mineralization (0.26% Sn and 0.91 oz/st Ag over 11.3 ft)(8). The erratic distribution, character, and grades of tin encountered in the drill holes is similar to rubble- and outcrop exposures at other significant breccia veins. Geochemical analysis (9) indicates less than 500 ppm Cu, Pb, or Zn are present in samples with high tin and silver values in the South vein drill hole samples.

Table 6. --Analytical results for samples of the South vein

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe %	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm
39	KS23192	120	19	>30000	366	7.8	244	455.0	>20000	365	1800
40	KS23193	20	12	3480	128	8.2	97	80.9	*6500	58	490
41	KS23191	16	-5	4930	274	14.0	187	142.0	1400	27	1400
42	KS23194	79	190	9280	506	24.0	551	601.0	18000	367	2200
43	KS23195	55	45	4900	688	21.0	558	1160.0	3800	110	1100
44	KS23190	15	30	2310	1028	32.0	2186	258.0	>20000	110	1200
45	KS27534	31	26	661	422	19.0	707	157.0	1400	29	380

Map Number	Sample Number	Sample Descriptions
39	KS23192	4 in greenish, cherty quartz vein, minor arsenopyrite and cassiterite
40	KS23193	Random chips of silicified crackle brecciated sandstone; minor cassiterite
41	KS23191	Random chips of gossany, brecciated siltstone; pieces up to 11 in
42	KS23194	Random chips of gossan veinlets and gossany fractured siltstone
43	KS23195	Random chips of 4 by 3 by 1.5 ft gossany, silicified brecciated sandstone
44	KS23190	Float: 4 in Fe-rich gossan vein
45	KS27534	Random chip of 8-10 ft blocks of gossany brecciated hornfels

Note: all map numbers reference locations on figure 2

Standoff Ridge Vein

The Standoff Ridge vein was discovered and drilled by Anaconda Minerals Co. in 1983 and 1984 respectively (9). Two shallow drill holes, spaced 200 ft apart, were designed to cut a northwest trending zone of arsenopyrite-bearing quartz veins and silicified crackle breccia. In the northern drill hole "four narrow southwest-dipping zones of local clay alteration associated with quartz-arsenopyrite vein mineralization" contained tin values in the range of 125-680 ppm and silver values that ranged from 1.1 to 4.6 oz/st over assay widths of 2 to 6 ft (9). Low silver grades (<3 ppm) were encountered in the drill hole to the south, and two 5 ft intervals contained 0.62 and 0.14% Sn near the bottom of the hole (9). According to an internal company report (8), the southerly drill hole missed the projected target suggesting that the structure dips steeply to the east. The mineralized intercepts at the bottom of the hole were suggested to represent altered igneous rock.

A random chip sample (map number 8, table 7) across this 55-ft-wide rubble exposure of silicified, gossany, crackle brecciated hornfels confirmed the minimal tin values (280 ppm) in this breccia system. Anaconda collected six 45- to 120-ft-long rock chip samples across this same exposure which contained 134 to 1,965 ppm Sn and 13 to 44 ppm Ag (8). A lens-like, arsenopyrite-bearing, quartz vein lies in the center of the breccia system and contains up to 8.48 ppm Au and >300 ppm Ag in select samples (map number 9, table 7). The quartz vein width does not exceed 1 ft.

A minimum strike length of 1,500 ft, and a potential strike length of 2,500 ft is indicated from the distribution of silicified and brecciated hornfels along a projected trend bearing 160° to the northwest.

Table 7. --Analytical results for samples of the Standoff Ridge vein

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe %	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm
8	KS27236	66	33	14300	149	3.7	55	56.9	280	46	260
9	KS27237	8480	>300	>30000	1035	16.0	160	471.0	140	40	5800

Map Number	Sample Number	Sample Description
8	KS27236	Random chip across 55-ft-wide silicified, gossany, crackle brecciated siltstone
9	KS27237	High-graded greenish chert-like matrix to brecciated milky white quartz vein

Note: all map numbers reference locations on figure 2

Dog Day Vein

One of the best exposed structures at the Won prospect is the Dog Day vein. Its minimum indicated strike length is 3,500 ft. Actual widths are difficult to determine, but based upon a few outcrops and large boulders of rubble, the breccia vein has a minimum average width of 6 to 7 ft. The orientation of the structure is 125° with a moderate dip to the south. The Dog Day vein contains tin values that range from 0.1 to 4.53% Sn (57-63, table 8). The vein is mostly composed of metal-oxide cemented, silicified and brecciated hornfels with localized areas of arsenopyrite-bearing quartz veining (table 8).

Gash Vein

The Gash vein was discovered, prospected, and drilled by Anaconda Minerals Co. in 1983 and 1984 (9). The vein system is exposed by a shallow hand-dug trench across a mineralized structure consisting "of three parallel gossan veins from 0.25 to 1.8 feet wide within a sheared and broken zone 15 feet wide" (9). Surficial expression of the structure is a wide, linearly oriented, iron stained rubblecrop. Anaconda Minerals Co. found up to 6.9% Sn and 3.3 oz/st Ag in their initial grab samples from the Gash vein (8). Trace element geochemistry of continuous chip samples from the prospect trench indicated up to 2,120 ppm Zn, >1,000 ppm As, 60 ppm Pb, 41 ppm Ag, 2,250 ppm Sn, and 2,250 ppm Sb (8). Bureau sampling (map number 66, table 9) found only minor base-metal values, minimal tin, and up to 86 ppm Ag.

One drill hole (-51°, bearing S44°W) was collared within 50 ft of the hand-dug trench and another drill hole was collared about 300 ft along strike to the northwest and drilled at an angle of -60°, bearing

N50°E. Significant tin values do not occur in either of the drill holes (values up to 0.061% Sn) and silver values ranged up to 4.44 oz/st over a width of 1.6 ft (9). A strike length of approximately 1,000 ft is indicated from rubblecrop exposures. Drilling did not provide information on dip orientation.

Table 8. --Analytical results for samples of the Dog Day vein

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe %	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm
57	KS27666	-	-	-	-	-	-	-	12800	-	-
58	KS27518	19	17	4380	341	8.7	2827	329	4500	18	240
60	KS27665	-	-	-	-	-	-	-	4800	-	-
61	KS27664	-	-	-	-	-	-	-	5800	-	-
62	KS27663	-	-	-	-	-	-	-	*45800	-	-
63	KS27662	-	-	-	-	-	-	-	1000	-	-

Map Number	Sample Number	Sample Descriptions
57	KS27666	Random chips of silicified, gossany, brecciated hornfels; estimated width 7-8 ft
58	KS27518	Random chips of 7-10 ft wide, cassiterite-bearing, Fe-oxide and silica cemented breccia
60	KS27665	Random chips of gossany, silicified, brecciated hornfels; estimated width 5-10 ft
61	KS27664	Random chips of 4.5-ft-wide zone of gossany, silicified brecciated hornfels
62	KS27663	Random chips of 6-ft-wide zone of gossany, silicified breccia; minor arsenopyrite
63	KS27662	Random chips of gossany, silicified brecciated hornfels, estimated width 5-10 ft

Note: all map numbers reference locations on figure 2

Table 9. --Analytical results for a sample of the Gash vein

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe %	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm
66	KS27520	170	86	2300	681	28.0	62	67.0	230	7	5200

Map Number	Sample Number	Sample Description
66	KS27520	Random chips of gossany siltstone breccia; gossan on joints and fractures

Note: map numbers reference locations on figure 2

Other Occurrences

Other occurrences of significant tin mineralization were also discovered in rubble crop or at a few poorly exposed breccia vein outcrops. For example, a buff-colored silicified brecciated siltstone with minor cassiterite and quartz forms a northwest-trending breccia vein at map location 13 (fig. 2). Random chip sampling yielded 1.13% Sn from this 2- to 3-ft-wide vein (map number 13, table 10).

At map location 1 (fig. 2, table 10), gossany, brecciated and silicified siltstone contained 1.18% Sn in select chips from a poorly exposed rubblecrop. Vegetation precluded tracing any veins at this location. however, it is worth noting that this occurrence is close to an altered andesite dike that contains up to 700 ppm Sn (map location 4, fig. 2, table 1).

Table 10. --Analytical results for samples of other vein occurrences

Map Number	Sample Number	Au ppb	Ag ppm	As ppm	Cu ppm	Fe %	Pb ppm	Sb ppm	Sn ppm	W ppm	Zn ppm	
1	KS27232	<5	45	444	1710	8.0	40	14.0	11800	15	1100	Chips of Fe-st, sili siltstone; qtz plus gssn veinlets
2	KS27233	<5	46	1530	2930	22.0	537	20.4	330	9	3300	5-in-wide banded gossany shear/ breccia vein
5	KS27234	<5	<5	35	77	2.0	3	5.2	150	10	<200	Random chips of sili, gossany frac-brecciated siltstone
6	KS27235	<5	55	246	547	23.0	3110	36.4	105	11	2700	High-grade of 5 in gossany breccia vein
7	KS27702	-	-	-	-	-	-	160	-	-	-	Random chips of sili, brec hnfl; minor aspy and Cu-staining
10	KS23189	<5	<5	66	45	4.4	9	4.4	200	8	<200	High-graded chip of 4-5-ft-wide sili brec; minor Fe and As staining
11	KS23188	<5	<5	13	23	3.9	<2	0.8	<5	<2	480	Carbonate-altered biotite andesite with minor sphalerite and chalcopyrite in carbonate
12	KS23187	69	<5	5500	300	10.0	13	15.0	230	309	1000	4 in Fe-gossan vein plus 2 in sheared gossany siltstone
13	KS25839	54	8	138	436	7.2	7	18.0	11300	16	1800	Random chips; 2-3-ft-wide silicified brecciated sandstone; minor cassiterite and quartz
14	KS27658	-	-	-	-	-	-	2900	-	-	-	Rubble: random chip of gossany brecciated hornfels
17	KS27659	-	-	-	-	-	-	950	-	-	-	Bedrock; random chip of qtz stockwork in hornfels
18	KS27508	35	13	1300	279	5.9	533	86.6	220	26	1100	Random chips of brecciated and gossany hornfels
23	KS27701	-	-	-	-	-	-	120	-	-	-	Random chips; quartz-veined brecciated hornfels; arsenopyrite; estimated width 5 ft
24	KS27523	51	75	2470	511	7.4	384	179.0	1500	66	<200	Random chips of sili, qtz-veined, gssn brec siltstone
25	KS27522	27	48	2270	326	8.6	2764	664.0	200	21	210	Random chips of sili, qtz-veined, gssn, brec siltstone
26	KS27521	6	<5	26	97	6.3	<2	2.1	97	<2	210	Biotite andesite dike; minor pyrrhotite and chalcopyrite in tourmaline fracture fillings
46	KS27509	544	17	>30000	470	6.3	15	229.0	35	<17	1600	Grab of 1-ft-wide anastomosing quartz veins with green, compact scorodite in voids
47	KS27512	<5	<5	296	58	24.0	2	14.0	53	20	7600	Random chips of 10-15-ft-wide, Fe-oxide cemented, brecciated siltstone
48	KS27510	<5	<5	126	90	<0.5	16	1.0	39	<2	<200	Grab of 10-ft-wide laminated leucocratic felsic dike
54	KS27538	15	23	3960	2000	19.0	1764	177.0	220	8	4800	Grab of <1-ft-thick wide gossany, brecciated siltstone
55	KS27537	20	71	3780	244	6.2	1386	459.0	470	12	640	Random chips off 9 by 6 by 3 ft gossany, silicified, brecciated-fractured siltstone
59	KS27517	<5	<5	1120	175	7.6	102	105.0	545	11	<200	Chip of 6-ft-wide Fe-oxide cemented breccia and silicified sandstone

Abbreviations: Fe-st = iron staining; sili = silicified; qtz = quartz; gssn = gossan or gossany; brec = breccia or brecciated; frac = fractured; aspy = arsenopyrite

Note: all map numbers reference locations on figure 2

TIN RESOURCE ESTIMATION

Estimation of the tin resource at the Won prospect is hampered by the sparsity and lack of continuity of vein outcrops, and by the extreme variability of tin concentrations in these structures. Distribution of tin minerals at the Won prospect is characterized by high-grade ore shoots surrounded by broader zones of lower-grade disseminated mineralization. The Gemini vein south, Tin Ridge, South, and the Prospect Pit vein structures exemplify these characteristics.

A resource estimate of the South and the Dog Day veins is made based upon a length of influence for each sample (in feet), the tin concentration, the average width of the sample, a 12 ft^3/st tonnage factor (based upon an average specific gravity of 2.42 for shale, abundant open space and minor metallic mineralization), and a 500 ft depth projection. Bureau method for estimating depth projection from surface geology is depth = ½ strike length. However, outcrops of these structures are so few that considerable uncertainty on the tenor of the deposits exists. A conservative estimate of 500 ft depth is therefore applied. Total strike length estimates are 4,540 and 3,220 ft respectively. Table 11 contains the pertinent data used in the resource calculations for the two veins.

Table 11. - Data for tin resource estimation calculations

Dog Day vein			South vein		
Estimated width	Sn ppm	Length of influence (ft)	Estimated width	Sn ppm	Length of influence (ft)
8.5	4,500	1,050	11.3	2,600	1,300
7.5	1,000	360	1.5	3,800	1,960
6.0	45,800	430	9.0	1,400	1,280
4.5	5,800	330	-	-	-
7.5	4,800	450	-	-	-
7.5	12,800	600	-	-	-

Using the above data, 981,875 st containing 20,286,625 lb of tin for the Dog Day vein and 1,153,333 st containing 4,992,331 lb of tin for the South vein is calculated. Approximately 25.3 M lb of tin are estimated to occur in these two structures.

An additional 7,700 linear feet of breccia vein is indicated from the above descriptions, exclusive of the Dog Day and South veins. Mineralization observed in these breccia veins is too erratic (Gemini veins) or are too poorly exposed (Tin Ridge) to permit any qualified estimation of the tin resource.

Even though the elements niobium and tantalum occur in sufficiently high concentrations in some tin deposits to be considered by-products, samples with high tin values from the Won prospect (appendix) did not show elevated tantalum or niobium values. A sample containing 44.5% Sn (map number 34, table 3) analyzed for niobium and tantalum by X-ray fluorescence contained only 7 ppm Nb and <3 ppm Ta respectively.

CONCLUSIONS

Tin deposits at the Won prospect were probably formed from late-stage, hydrothermal fluids which may be related to an underlying and unexposed pluton. Andesite and rhyolite dikes exposed in the prospect area are believed to represent differentiated fractions of the parent magma. Overlying sedimentary rocks were metamorphosed to hornfels as a result of pluton emplacement and were subsequently subjected to extensive tourmalinization and silicification during a period of brittle deformation. Northwest-trending veins of crackle breccia developed in concert with quartz-tourmaline alteration and were mineralized with cassiterite and base-metal-sulfide minerals. Arsenopyrite, pyrrhotite, sphalerite, chalcopyrite, and tetrahedrite were observed in some veins, but weathering oxidized most of the original sulfide minerals. Cassiterite occurs as a matrix in breccia veins and as drusy coatings on open-space fracture surfaces. Cassiterite often occurs in the absence of sulfide minerals.

Based upon limited sampling (few outcrops), a tin resource estimate of approximately 25.3 M lb of tin is estimated for two of the principal breccia veins, the Dog Day and the South veins. Additionally, an aggregate of 7,700 linear feet of tin-mineralized breccia vein can be estimated from projections between widely spaced bedrock and rubblecrop exposures of other individual breccia vein occurrences. Combining these additional breccia veins with the inferred tin resource of 25.3 M lbs of tin for the Dog Day and South veins, an inferred resource estimate might be doubled to 50.6 M lbs of tin.

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APPENDIX

ADDITIONAL ANALYTICAL RESULTS FOR ROCK SAMPLES

Sample Number	Ba ppm	Br ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %
KS23187	<100	14	42	<29	<10	160	1	<2	10.0
KS23188	1500	<1	<10	53	17	51	3	<2	3.9
KS23189	<100	<1	<10	60	<10	230	<1	<2	4.4
KS23190	340	6	<10	42	<10	85	<1	2	32.0
KS23191	260	9	19	<30	<10	260	<1	<2	14.0
KS23192	500	65	<68	<79	<10	<240	<2	<5	7.8
KS23193	560	10	<10	<23	17	130	3	<2	8.2
KS23194	470	142	<43	<60	<10	180	<1	<2	24.0
KS23195	<460	141	73	<100	<10	<220	<2	<7	21.0
KS23429	<100	6	<10	32	<10	120	<1	<2	23.0
KS25839	<100	<1	<10	13	14	180	2	<2	7.2
KS27232	140	2	<10	25	<10	130	<1	<2	8.0
KS27233	150	7	57	<10	13	<50	<1	<2	22.0
KS27234	<100	<1	<10	24	<10	250	<1	<2	2.0
KS27235	<100	2	<10	<10	<10	140	1	<2	23.0
KS27236	<310	123	<50	<71	<10	240	<1	<2	3.7
KS27237	<890	23	<120	<140	<21	<430	<5	<7	16.0
KS27501	<100	11	<10	<45	<10	230	<1	<2	3.5
KS27502	<360	46	<49	<55	32	<170	<1	3	5.7
KS27503	770	<1	<10	50	31	110	24	<2	6.7
KS27504	190	11	<10	<23	<10	230	3	<2	6.3
KS27505	<430	192	<68	170	21	490	<2	<5	4.0
KS27506	1500	<1	<10	51	30	140	35	<2	7.3
KS27507	210	5	<10	39	<10	170	<1	<2	5.2
KS27508	220	5	<10	24	<10	160	<1	<2	5.9
KS27509	<420	53	<58	<65	<10	320	<2	<2	6.3
KS27510	120	<1	<10	10	<10	<50	8	<2	<0.5
KS27511	180	74	<43	<39	<10	200	<1	<2	3.1
KS27512	610	2	14	21	54	78	6	<2	24.0
KS27513	<100	6	<10	<10	<10	250	<1	<2	5.7
KS27515	360	4	<10	26	<10	200	3	<2	10.0
KS27517	370	5	<10	24	<10	250	<1	<2	7.6
KS27518	360	7	<10	<30	11	130	<1	<2	8.7
KS27519	<100	<1	<10	<10	<10	240	<1	<2	1.2
KS27520	160	6	26	<10	14	88	3	<2	28.0
KS27521	600	<1	<10	56	47	290	35	<2	6.3
KS27522	<230	72	<36	<47	<10	170	<1	<2	8.6
KS27523	<100	7	<10	<10	<10	210	<1	<2	7.4
KS27524	<100	3	<10	27	<10	260	<1	<2	4.3
KS27525	<100	2	<10	28	<10	290	<1	<2	3.3
KS27526	<100	2	<10	37	<10	220	<1	<2	4.0
KS27527	<100	2	<10	36	<10	230	<1	<2	6.2
KS27528	<100	3	<10	25	<10	210	<1	<2	6.8
KS27529	<100	4	<10	22	<10	180	<1	<2	<6.5
KS27530	110	7	<10	35	<10	200	<1	<2	7.6
KS27531	110	4	<10	72	<10	180	<1	<2	9.0
KS27532	<100	16	<10	17	<10	230	<1	<2	7.6
KS27533	110	3	<10	<10	<10	260	<1	<2	7.1
KS27534	<100	5	<10	39	<10	110	<1	<2	19.0
KS27535	280	12	<10	<30	<30	<10	180	<1	13.0
KS27537	<210	5	<10	<30	<10	150	<1	<2	6.2
KS27538	400	10	<10	<25	23	150	<1	4	19.0
KS27539	<230	6	<22	<38	<10	99	<1	<2	10.0

APPENDIX, CONTINUED

Sample Number	Hf ppm	Ir ppb	La ppm	Lu ppm	Mo ppm	Na %	Ni ppm	Rb ppm	Sc ppm
KS23187	<2	<100	18	<.05	6	0.28	<50	<25	8.0
KS23188	3	<100	29	<.05	<2	2.0	<50	76	12.0
KS23189	3	<100	38	<0.5	<2	0.43	<50	<10	10.0
KS23190	<2	<100	42	<0.5	<2	0.22	68	<24	12.0
KS23191	<2	<100	18	<0.5	8	0.33	<50	<25	9.2
KS23192	<8	<320	69	<1.9	31	<0.49	<87	<63	8.0
KS23193	<2	<100	24	<0.5	<2	0.28	77	59	10.0
KS23194	<5	<100	24	<1.1	9	0.34	<50	<30	7.3
KS23195	<8	<270	25	<2.0	<11	<0.93	70	<49	5.4
KS23429	<2	<100	26	0.6	4	0.21	<50	<10	6.9
KS25839	<2	<100	9	<0.5	<2	<0.05	<50	10	4.6
KS27232	<2	<100	16	<0.5	<2	0.34	<50	<10	11.0
KS27233	<2	<100	8	<0.5	<2	0.36	<50	<10	13.0
KS27234	3	<100	12	<0.5	<2	0.28	<50	<10	7.6
KS27235	<2	<100	10	<0.5	<2	0.15	<50	16	5.7
KS27236	<6	<100	17	<1.4	<8	0.27	<53	<35	7.4
KS27237	<15	<560	<5	<3.3	42	<0.58	<160	<110	<2.4
KS27501	<2	<100	15	<0.5	<5	0.2	<50	<10	12.0
KS27502	<6	<230	<5	<1.3	29	<0.23	140	<47	7.9
KS27503	3	<100	27	<0.5	<2	2.2	120	140	16.0
KS27504	<2	<100	10	<0.5	4	0.50	<50	<21	8.5
KS27505	<8	<260	94	<1.9	14	<0.48	130	<46	6.9
KS27506	2	<100	26	<0.5	<2	2.0	240	190	16.0
KS27507	<2	<100	24	<0.5	4	0.49	<50	18	10.0
KS27508	3	<100	10	<0.5	3	0.4	<50	<10	8.9
KS27509	<7	<270	<5	<1.6	<11	<0.31	84	<53	4.6
KS27510	2	<100	<5	<0.5	<2	1.40	<50	260	2.9
KS27511	<2	<100	9	<0.5	<5	0.25	<50	<10	7.2
KS27512	3	<100	17	<0.5	<2	0.07	140	43	10.0
KS27513	<2	<100	15	<0.5	4	0.37	<50	<10	8.3
KS27515	3	<100	19	<0.5	<2	0.27	<50	32	8.3
KS27517	<2	<100	12	<0.5	3	0.28	<50	<10	6.0
KS27518	<2	<100	12	<0.5	<2	0.23	80	<26	4.9
KS27519	3	<100	<5	<0.5	<2	0.26	<50	<10	5.9
KS27520	<2	<100	12	0.6	<2	<0.05	66	19	8.6
KS27521	<2	<100	30	<0.5	<2	1.3	65	120	17.0
KS27522	<2	<100	14	1.3	12	0.48	57	<25	6.3
KS27523	<2	<100	18	<0.5	11	0.38	<50	<10	8.6
KS27524	2	<100	21	<0.5	<2	0.52	<50	<10	10.0
KS27525	4	<100	17	<0.5	<2	0.54	<50	<10	10.0
KS27526	4	<100	21	<0.5	<2	0.48	<50	<10	10.0
KS27527	4	<100	24	<0.5	<2	0.5	<50	<10	11.0
KS27528	3	<100	19	<0.5	<2	0.44	<50	<10	9.4
KS27529	3	<100	18	<0.5	<2	0.46	<50	<10	11.0
KS27530	<2	<100	23	<0.5	4	0.42	<50	<10	10.0
KS27531	3	<100	42	<0.51	<2	0.42	<50	<10	10.0
KS27532	5	<100	18	<0.5	8	0.41	<50	14	10.0
KS27533	<2	<100	14	<0.5	2	0.38	<50	<10	11.0
KS27534	<2	<100	20	<0.5	<2	0.25	<50	<!0	5.1
KS27535	<2	<100	11	<0.5	<4	0.29	<50	<27	9.3
KS27537	<2	<100	16	<0.5	7	0.32	<50	<26	7.4
KS27538	<2	<100	22	<0.5	<2	0.24	110	<22	5.8
KS27539	<2	<100	10	<0.5	9	0.31	<50	<29	4.3

APPENDIX, CONTINUED

Sample Number	Se ppm	Sm ppm	Ta ppm	Tb ppm	Te ppm	Th ppm	U ppm	Yb ppm	Zr ppm
KS23187	<10	4.1	<1	<1	<62	5.0	1.5	14	<500
KS23188	<10	5.6	1	1	<20	10.0	3.4	<5	<500
KS23189	<10	6.1	<1	<1	<20	5.9	2.0	<5	<500
KS23190	99	11.0	<1	<1	<57	6.1	2.8	<5	<500
KS23191	<10	4.1	<1	<1	<63	4.8	0.7	16	<500
KS23192	<47	14.0	3	<1	<190	4.8	<3.2	74	<2300
KS23193	<10	5.0	<1	<1	<48	5.7	1.4	13	<500
KS23194	<27	4.6	<1	<1	<89	3.3	<1.6	28	<500
KS23195	<47	6.3	2	<1	<160	7.7	<2.7	27	<1500
KS23429	27	5.7	<1	1	<20	3.0	1.1	8	<500
KS25839	<10	2.0	<1	<1	<20	2.1	0.8	<5	<500
KS27232	16	3.9	<1	<1	<20	3.9	1.9	<5	<500
KS27233	<10	2.3	<1	<1	<20	5.1	1.6	6	<500
KS27234	<10	2.5	<1	<1	<20	5.1	1.9	<5	<500
KS27235	12	2.1	<1	<1	<20	2.0	0.6	<5	<500
KS27236	<33	3.8	<1	<1	<110	7.4	<1.9	17	<1100
KS27237	<83	0.7	<4	<3	<330	<5.8	<5.6	110	<4200
KS27501	<10	2.7	<1	<1	<41	1.6	1.9	20	<500
KS27502	<33	2.6	2	<1	<140	5.2	<2.2	52	<1700
KS27503	<10	7.4	<1	1	<20	5.0	2.6	<5	<500
KS27504	<10	2.5	<1	<1	<51	6.3	1.5	13	<500
KS27505	<45	17.0	<1	<1	<150	6.6	<2.6	31	1900
KS27506	<10	7.0	1	<1	<20	6.9	2.0	7	<500
KS27507	15	5.1	<1	<1	<20	7.1	2.0	5	<500
KS27508	<10	2.4	<1	<1	<20	7.1	2.0	5	<500
KS27509	<40	1.4	<1	<1	<160	3.4	<2.7	46	<1900
KS27510	<10	2.3	5	1	<20	13.0	5.2	<5	<500
KS27511	<10	2.5	<1	<1	<53	5.0	<0.5	12	<500
KS27512	<10	3.8	<1	<1	<20	5.2	4.7	<5	<500
KS27513	36	3.5	<1	<1	<42	5.3	1.2	8	<500
KS27515	<10	4.2	<1	<1	<20	4.5	2.2	<5	<500
KS27517	<10	2.6	<1	<1	<20	3.4	1.6	6	<500
KS27518	<10	3.4	<1	<1	<70	3.4	1.1	17	<500
KS27519	<10	0.5	<1	<1	<20	2.4	1.2	<5	<500
KS27520	<10	3.4	<1	<1	<20	3.5	1.7	<5	<500
KS27521	<10	6.0	1	1	<20	5.5	2.1	<5	<500
KS27522	23	3.2	<1	<1	<76	5.4	<1.3	23	<500
KS27523	34	3.5	<1	<1	<44	13.0	2.0	8	<500
KS27524	<10	3.6	<1	<1	<20	5.4	2.6	<5	<500
KS27525	<10	3.8	1	<1	<20	4.7	2.7	<5	<500
KS27526	<10	3.7	1	<1	<20	5.1	2.6	<5	<500
KS27527	<10	4.7	1	<1	<20	7.5	2.8	<5	<500
KS27528	<10	4.1	1	<1	<20	5.3	2.3	<5	<500
KS27529	11	3.3	1	<1	<20	4.8	2.5	<5	<500
KS27530	<10	4.5	1	<1	<20	6.6	2.3	6	<500
KS27531	<10	8.1	1	<1	<20	5.0	2.3	<5	<500
KS27532	29	3.9	1	<1	<20	4.1	2.8	<5	<500
KS27533	<10	2.9	<1	<1	<20	4.1	3.0	<5	<500
KS27534	21	5.6	<1	2	<20	3.0	1.1	7	<500
KS27535	<10	4.6	<1	<1	<69	4.2	1.4	17	<500
KS27537	<10	3.6	<1	<1	<71	4.8	1.2	20	<500
KS27538	<10	10.0	<1	<1	<54	9.3	3.7	11	<500
KS27539	<21	2.7	<1	<1	<75	3.8	1.6	17	<1100

Note - The analytical method for all analyses is by instrument neutron activation analysis.